reaction layer and disposed across said polymer electrolyte, a separator having a means for supplying a fuel gas to said anode, a separator having a means for supplying an oxidant gas to said cathode, a current collector plate, an insulating plate and an end plate,

B1 Cont'd.

said fuel cell further comprising a total heat exchanger for concurrently moving heat and humidity from a discharged gas toward said fuel gas and oxidant gas being installed inside the end plates disposed on both ends of said polymer electrolyte fuel cell, or between said insulating plate and either said current collector plate or said end plate, and said total heat exchanger effecting total heat exchange via a polymer electrolyte membrane, which is the same as that constituting said unit cell and has a thickness of 25 μm or less.--

REMARKS

Claim 1 is the only pending claim in the application.

In response to the Examiner's objection, claim 1 has been amended to replace "an" with "a" in line 10 of the claim. No new matter has been added, and entry is respectfully requested.

The Examiner has rejected claim 1 under 35 U.S.C. § 103(a) as being unpatentable over JP 6-132038 ("JP '038") in view of JP 9-204924 ("JP '924") and in further view of WO 95/25357 ("WO '357"). The Examiner argues that JP '038 teaches a fuel cell stack comprising a unit cell composed of a polymer electrolyte membrane 2 catalyst layers 3, 4 and separator plates having gas passages 6, 7, and that total heat exchangers 11, 21 for concurrently moving heat and humidity from discharged gases towards the incoming fuel and oxidant gases are present in the system. The Examiner acknowledges that JP '038 does not expressly teach (1) the presence of end plates on the fuel cell stack or that the total heat exchangers are located inside the end plates (i.e., within the fuel cell stack); (2) the thickness of the polymer electrolyte

membranes or that the heat exchangers comprise polymer electrolyte membranes which are the same as those in the unit cells; and (3) the presence of current collector or insulating plates in the stack.

However, the Examiner contends that JP '924 teaches to a solid polymer fuel cell stack having a humidification unit 11 contained within the end plates 16 of the stack, polymerized "dummy" (i.e., insulating) plates, and that "the solid-state polyelectrolyte layer[s]" are used in the humidifiers. Moreover, the Examiner contends that WO '357 is directed to a fuel cell stack comprising a humidification section and that the stack comprises bus (i.e., current collector) plates 46, 48 at the edges of the active section.

The Examiner concludes that the invention as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made because the artisan would be motivated by the disclosure of JP '924 to incorporate the total heat exchangers of JP '038 into (i.e., between the end plates of) the stack of JP '038 and to use polymer electrolyte membranes ("PEM") in the heat exchangers. The Examiner also concludes that the artisan would be motivated to incorporate the dummy (insulating) plates of JP '924 and the current collector plates of WO '357 into the fuel cell stack of JP '038.

Applicants respectfully but strenuously traverse the Examiner's rejection and the arguments in support thereof for the reasons set forth in detail below.

To establish a *prima facie* case of obviousness, the Examiner must show the following three essential criteria to support the rejection: (1) that the references teach or suggest all elements of the claims; (2) that the cited references provide motivation to modify and combine the references as suggested by the Examiner; and (3) that the references provide a basis for a reasonable expectation of success from such a modification and/or combination. The

suggestion to modify and/or combine and the reasonable expectation of success must come from the references without reference to Applicants' specification.

Importantly, with regard to the first criterion, the Examiner admits that JP '038 does not teach or suggest all of the elements of the present invention. Applicants contend that JP '924 in no way cures the deficiencies of JP '038. The present invention comprises, in part, a 25 μm thick or less PEM total heat exchanger that is installed inside the end plates at both ends of the fuel cell such that the total heat exchanger effectively transfers heat and humidity from a discharge gas concurrently toward fuel and oxidant gases (see claim 1 and page 5, lines 8-20).

In contrast, the humidifier of JP '924 uses a gas impermeable base 1 to form a "laterally reciprocating and meandering" cooling water passage 2 and a "laterally reciprocating and snaking" gas passage which are mutually opposed through a polymer electrolytic film 10 such that the passages have inlets 3, 7 and outlets 4, 8 which enable a gas to be humidified by evaporated cooling water on the gas side of the humidifier (abstract). Thus, not only are the materials of construction of the two inventions different, but structural features of the present

So?

invention differ from the features described in JP '924. For example, the structure and placement of the end plates of the present invention allow the total heat exchanger to omit or reduce pipes that would otherwise be necessary for supplying humidified and heated supplied gas to the polymer electrolyte fuel cell ("PEFC") (page 6, lines 15-19). This advantage, which is not taught

Doesn't have to suggest this

or suggested by the JP '924, eliminates any temperature drop that would otherwise occur as the fuel and oxidant gases proceed toward the PEFC and, therefore, also eliminates the need for insulating pipes which would otherwise connect the total heat exchanger to the PEFC (page 6, lines 19-24).

Similarly, the insulating plates of the present invention are different from the dummy plates 15 described in JP '924. Whereas JP '924 does not teach or suggest any specific purpose of the "dummy" plates (hence the name), the insulating plates of the present invention have a specific purpose and provide similar or the same advantages provided by the end plates. Also, as acknowledged by the Examiner, the insulating plates prevent unwanted electrical contact of the fuel cells with the humidification and/or end plates. As such, the structure of the present invention, and in particular the end and insulating plates of the total heat exchanger, enable heat to be preserved in a simple, cost-effective, yet novel, embodiment.

Applicants also argue that the cited references do not provide motivation to modify and combine the references as suggested by the Examiner. Applicants most strenuously disagree that an artisan would be motivated to incorporate the heat exchangers of JP '038 between the end plates of the stack of JP '038 based on the disclosure and understanding that "by uniting with the stack of a power generation area in the humidification area of a fuel cell, the gas humidifier of PEM type fuel cell of this invention can perform the above-mentioned humidification technique accurately, and it can attain miniaturization of a fuel cell while [in] operation by which the fuel cell was stabilized can be preformed." In support of this argument, Applicants assert that the term "uniting" is overly broad and, therefore, insufficiently describes the information necessary to motivate an artisan to effectively incorporate the heat exchangers of JP '038 between the end plates of the stack of JP '038. This is especially true considering that heat exchange between discharged water and supplied gas previously necessitated larger scale heat exchangers in order to achieve a desired heat exchange efficiency (page 4, lines 8-14). Thus, while the heat exchanger in JP '038 could theoretically be incorporated between the end plates of the stack of JP '038 while maintaining "miniaturization" of a fuel cell, there is no

motivation to do so as the heat exchange efficiency and, therefore, the efficiency of the fuel cell as a whole, would not be maintained.

Therefore, it follows that an artisan must also have an understanding of the specific structure of the total heat exchanger of the present invention in order to effectively and efficiently incorporate the heat exchangers of JP '038 between the end plates of the stack of JP '038. The structure of the total heat exchanger that comprises the claimed invention includes a PEM between two sheets of 180 μm thick hydrophilicity treated carbon paper such that the external side of the carbon paper is between two thin plates having identical gas flow channels as the separator plate channels that comprise a unit cell resulting in a single unit heat exchange internal humidifier (page 10, lines 11-18). By combining 40 unit heat exchangers, for example, a total heat exchanger is created wherein 20 layers are an oxidant gas humidifier and the remaining 20 layers are a fuel gas humidifier (page 10, lines 18-24). A total heat exchange plate separates the oxidant gas humidifying unit from the fuel gas humidifying unit humidifier permitting total heat exchange (page 10, line 24- page 11, line 3). Further, the internal humidifier of the present invention enables the oxidant gas to enter the humidifier in parallel with the gas flow channel. The oxidant emerging from the internal humidifier is then supplied back to the PEFC and the oxidant gas discharged from the PEFC enters the internal humidifier in parallel with the gas flow channel located between the membrane and the other thin plates and is discharged (page 11, lines 4-15). Applicants assert that neither JP '924 nor JP '038 teach or suggest the specific structure of the total heat exchanger as described above. Therefore, JP-924 does not provide any motivation to modify JP-038 as suggested by the Examiner as any desire to incorporate the heat exchanger of JP-038 between the end plates of the stack of JP '038, without also incorporating the specific

structure of the total heat exchanger of the present invention, would not have any reasonable expectation of success.

In response to the Examiner's conclusion that the artisan would be motivated to incorporate the dummy plates of JP '024 into the fuel cell stack of JP '038 and to use PEM in the heat exchangers of JP '038, Applicants argue that, having established that there would be no motivation to incorporate the heat exchangers of JP '038 between the end plates of the stack of JP '038, it naturally follows that there would be no need and, therefore, no motivation to incorporate the dummy plates of JP '024 into the fuel cell stack of JP-038 or to use PEM in the heat exchangers of JP '038.

Moreover, WO '357 in no way cures the deficiencies of JP '038 and JP '924 for the same reasons discussed above. Besides, WO '357 is directed to a fuel cell stack having a humidification section which is located upstream from the electrochemically active section (abstract). Also, the inlet fuel and oxidant streams are introduced into the humidification section without first being directed through the electrochemically active section and the bus plates 46, 48 are located on opposite ends of the active section 34. Thus, there is no motivation to combine the references in the manner suggested by the Examiner. For all the reasons set forth above, Applicants assert that claim 1 is not obvious in view of WO '357 either alone or in combination with the other cited prior art.

Finally, Applicants argue that even if *prima facie* obviousness could be shown based on any of the above-noted references or combination of references, such *prima facie* obviousness is sufficiently overcome by Applicants' improved and unexpected results such as demonstrated, for example, in Example 1 of the present application (see page 11, line 22 to page 12, line 9).

In addition, the PEFC of the present invention also demonstrated its novel utility during a electrical-power generation test under conditions of 80% fuel utilization, 40% oxygen utilization and a current density of 0.7 A/cm^2 (page 13, lines 11-16). The test established that the PEFC of the present invention was capable of generating electric power while also preserving a battery voltage of at least 31 volts for more than 5,000 hours. Also, the PEFC of the present invention continued to operate effectively even when the flow rate of the cooling water was adjusted so that its discharge temperature was about 85°C at the outlet of the PEFC. These results confirm that cooling water at a temperature as high as about 85°C can be used effectively as a heat source in the PEFC of the present invention (page 13, lines 17-22). Thus, the claimed invention effectively overcomes some of the prior problems associated with PEFC electrical power generating systems including their inability to provide a sufficient heat source and, therefore, heat exchange between PEFC discharge water and supply gas which previously necessitated liquid-gas heat exchange which resulted in excessive scaling of heat exchangers and reduced system efficiency (page 4, lines 3-16).

In view of the foregoing remarks, Applicants submit that pending claim 1 complies with the requirements of § 112 and is patentably distinct from the prior art. Reconsideration and withdrawal of the rejection and an early Notice of Allowance are respectfully requested.

Respectfully submitted,

KAZUHITO HATOH *ET AL*.

1/21/03 By: Will C. Youngblood

(Date)

WILLIAM C. YOUNGBLOOD
Registration No. 50,524
AKIN, GUMP, STRAUSS, HAUER & FELD, L.L.P.
One Commerce Square
2005 Market Street - 22nd Floor
Philadelphia, PA 19103-7086
Telephone: (215) 965-1200
Direct Dial: (215) 965-1246
Facsimile: (215) 965-1210
E-Mail: wyoungblood@akingump.com

WWS:WCY:jem

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Marked-Up Version of Claim 1

--1. (Twice Amended) A polymer electrolyte fuel cell comprising a unit cell composed of a polymer electrolyte membrane, a cathode and an anode each having a catalyst reaction layer and disposed across said polymer electrolyte, a separator having a means for supplying a fuel gas to said anode, a separator having a means for supplying an oxidant gas to said cathode, a current collector plate, an insulating plate and an end plate,

said fuel cell further comprising a total heat exchanger for concurrently moving heat and humidity from [an] a discharged gas toward said fuel gas and oxidant gas being installed inside the end plates disposed on both ends of said polymer electrolyte fuel cell, or between said insulating plate and either said current collector plate or said end plate, and said total heat exchanger effecting total heat exchange via a polymer electrolyte membrane, which is the same as that constituting said unit cell and has a thickness of 25 μm or less.--